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SYSTOLIC BLOOD-PRESSURE FLUCTUATIONS WITH SEX, ANGER AND FEAR

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INTRODUCTION

Since the first demonstration by Stephen Hale of the pressure of blood within the arterial system, physiologists have given a great deal of attention to the problem. Today, a great many facts are known about the causes and relationships of arterial blood-pressure. Blood-pressure is considered the result of a number of complex factors and is thoroughly integrated with the other organic systems. Although there are still many factors of normal variations that have not been successfully analyzed, the relationship of blood-pressure to many pathological conditions is understood. With the attachment of clinical significance to blood-pressure changes, normal variations were studied in more detail. Emotion has been considered one of the most frequent causes of normal variations. For example, it is customary for the physician to discount the first reading or two on a new patient because of this factor.

In recent years several attempts have been made to analyze experimentally the relationships of blood-pressure changes to specific emotions.

Marston (12) found that anger and fear were accompanied by a rise in systolic pressure. The former was characterized by an abrupt rise of short duration, the latter, by a more gradual rise of longer duration. Sex produced a distinct drop in systolic pressure. Further conclusions were that anger is the most characteristic emotion in females, and fear in the male. The same experimenter in a later work (13), (14) reduces the emotions of anger, sex and rage to the elements, compliance, submission,

dominance and inducement, the first two producing a drop in systolic blood-pressure and the latter two a rise in systolic blood-pressure. Sex differences were also reported. Cannon (5) makes the statement that all emotional rises of systolic blood-pressure above 12 mm. are due to fear, anger or pain.

Landis and Guillette (10) after a careful and extended investigation arrive at quite different conclusions. A great variety of situations were used as emotional stimuli. The number of individuals used was limited to 22. They find a rise for sex, a decrease for anger or no change at all, and a slight rise for fear. They conclude that there is no reaction pattern for specific emotions except the sharp rise due to the "choc" of surprise. The degree of emotion has no correlation with degree of blood-pressure fluctuation.

Dumas (7) reported an increase in retinal blood-pressure under emotion.

Numerous experiments have been performed on the relation of cardiac and vasomotor changes to emotion but as they are independent variables of blood-pressure they will not be included here.

Darrow (6) in contrasting the difference in physiological reactions to sensory and ideational stimuli concludes the latter to be more effective in increasing cardiac activity as indicated by systolic blood-pressure and pulse rate, while the former is more effective on peripheral mechanisms such as vasoconstriction. Syz (18) from the results of an experiment with the psychogalvanometer concludes that examination of visceral changes in emotion does not give us any information as to the differential feature of emotional states. He also stresses the unreliability of subjective reports of emotional experiences.

In the field of abnormal emotions a rise of systolic blood-pressure is reported with both excitement and depression in the insane (16). It has also been pointed out that cardiac irregularities may be conditioned by a single strong stimulus (4).

Blood pressure fluctuation has been used as a test of deception. Marston (15) found blood-pressure fluctuations 95 per cent correct. Burtt (2) reports a partial confirmation of Marston's

work. Landis and Wiley (11) in checking Burtt's work could not distinguish deception more than 40 per cent of the time. Washburn states (19) in a review of the subject, that definite conclusions are largely negative. The bearing this work has on the relation of blood-pressure to emotions, specific or general, is very obscure if not entirely negative. There is, at present, no agreement as to the emotions involved in the consciousness of deception.

Very little work has been done on the diastolic blood-pressure as a correlate of emotion. Cabot (3) states that the diastolic blood-pressure does not fluctuate with emotion. Binet says the diastolic is only altered by pain and that any change of systolic blood-pressure is a compensatory change (6).

Normal or unemotional fluctuations of blood-pressure are demonstrable, although in many instances their physiological cause is obscure. The effect of physical exercise via cardiac activity on systolic pressure is well known. Wyse and Lutze (20) report a general rise of systolic blood-pressure during the day with a gradual drop of the diastolic blood-pressure. They found an average rise of 8 mm. during ingestion of meals with no change in diastolic pressure. Erlanger and Hooker (8) explain diurnal rhythm on the basis of ingestion alone. In contradiction to these findings other investigators (17) report a diurnal rise of systolic blood-pressure with fasting and no daily rhythmic change of pressure. They also report a rise of both systolic and diastolic pressures with ingestion of food.

Sudden fluctuations of systolic blood-pressure in a perfectly relaxed condition and with no consciousness of emotion, are reported by Landis and Guillette (10). Investigators in this field agree that systolic blood-pressure fluctuates with emotion. There is, however, no agreement as to the relation of the fluctuation to specific emotions.

STATEMENT OF PROBLEM

The object of the present work is: (*a*) to determine the correlation between introspective report and systolic fluctuations, (*b*) to determine whether or not there are characteristic systolic changes with the emotions of sex, anger and fear, (*c*) to analyze the range or distribution of these changes over a selected group.

METHOD AND PROCEDURE

A. Subjects

The tests were made on 100 men. Their ages range from 19 to 31, 86 per cent between 21 and 25 inclusive. All of the subjects were in good physical condition and had no gross pathological condition of the cardio-vascular or related systems. They were all Sophomore medical students and had accordingly, a more or less common associative background (stock of ideas).

Readings for each subject were taken over a period of several weeks preceeding the test to determine the normal blood-pressure. All of the men were familiar with the subject of blood-pressure, the technique and general clinical interpretations and were, therefore, less prone to psychic or emotional influences produced by the act of taking a reading.

B. Apparatus and technique

It is generally conceded that there are no universal stimuli for specific emotions. Emotions are aroused normally by situations, not specific sensory stimulation. In order to simulate emotional situations in the laboratory, a motion picture film was prepared containing three situations designed to arouse the emotions of (love) sex, anger and fear respectively. The picture was in the form of a simple "story" in order to maintain continued interest and initiate a receptive mental state for the emotional situations. Each of the situations appeared naturally with the development of the plot. They were separated by intervals of approximately ten minutes. The length of time required for the whole film was forty minutes. The situation used in arousing the emotion of sex was the usual love scene of the "movies" plus a suggestive dance. For an anger situation a scene was used in which the suitor (who was also the hero of the story) was treacherously betrayed and rejected by his lover and finally beaten into unconsciousness and thrown out on the street. The fear situation was a scene portraying the destruction of the city by an earthquake. The catastrophe involved the leading characters of the story. The fear situation was re-inforced by

producing a sudden loud noise. No attempt was made to discriminate the reactions due to the "choc" of surprise and those due to the emotion aroused by the screen at this point.

In order to eliminate subjective error on the part of the experimenter, the blood-pressure determinations were made graphically with the Tycos Recording Syphgmomanometer by the usual technique (1). The subject was completely separated by a partition from the experimenter and instrument. Before commencing the test the subject was required to rest for fifteen minutes. Following this as many readings were taken as necessary to get the temporary normal. In most instances two or three readings were required before the blood-pressure dropped to the usual level. During the presentation of the film readings were taken immediately preceeding, at the time of stimulation, and immediately succeeding the emotional situation.

C. Factors involved

The tests were made at the same time each day (7 P.M. to 11 P.M.). Physical conditions, room, apparatus, furniture, etc. were constant for the whole group. The standard sitting position of the subject was approximately the same for each case. Outside influences of a disturbing nature were eliminated. No subjects were used whose mental state, temporary or permanent, was incompatible with the purpose of the experiment, i.e., worry, nervousness, depression.

At the completion of the test the subject was asked to fill out the following form:

Date.....

Age.....

Scene A (nude dancing girl) presented an emotional situation of sex. Were you conscious of a similar feeling in yourself? Indicate the degree by checking one of the following:

Very strong.....
Strong.....
Moderate.....
Weak.....
Very weak.....

Scene B (flogging scene) presented an emotional situation of anger. Were you conscious of a similar feeling in yourself? Indicate the degree by checking one of the following:
Very Strong.....
Strong.....
Moderate.....
Weak.....
Very weak.....

Scene C (destruction of city plus noise) presented an emotional situation of fear. Were you conscious of a similar feeling in yourself? Indicate the degree by checking one of the following:
Very Strong.....
Strong.....
Moderate.....
Weak.....
Very Weak.....

Do you consider yourself "emotional"? Indicate the degree by checking one of the following:
Very Strong.....
Strong.....
Moderate.....
Weak.....
Very Weak.....

Was your attention distracted by the pressure on your arm? Indicate the degree by checking one of the following:
Very Strong.....
Strong.....
Moderate.....
Weak.....
Very Weak.....

Had you seen this picture before?.....

The criticism might be made that the context of the report would suggest, to some extent, the emotion in question, as has been pointed out by the investigations of Jarden and Fernberger (9) with the Piderit profile. In their work the suggestion is given preceding or simultaneously with the stimulus. Since in the present case the suggestive element is with-held for a considerable time after the stimulus (forty minutes) the factor of suggestion is probably eliminated.

The terms Very Strong, Strong, Moderate, Weak and Very

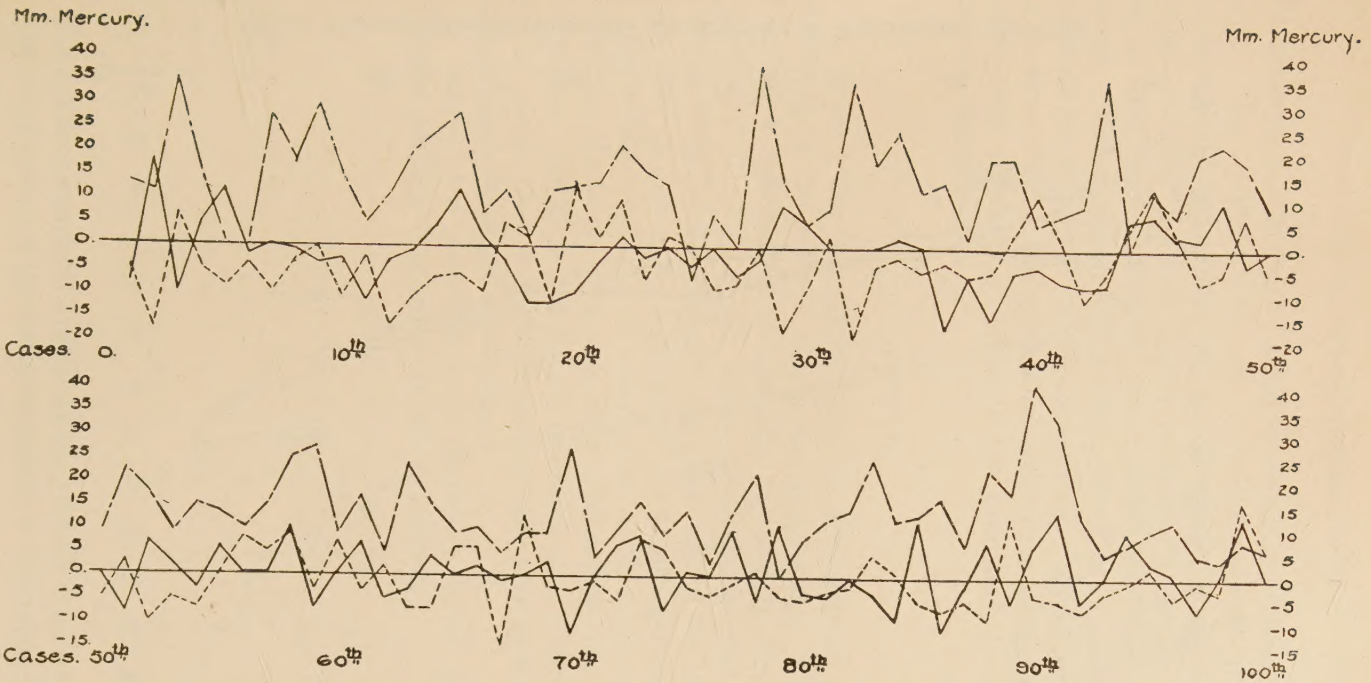

FIG. 1. SHOWING SYSTOLIC FLUCTUATIONS FOR EACH INDIVIDUAL WITH SEX, ANGER AND FEAR

Sex ————

Anger ————

Fear ----------

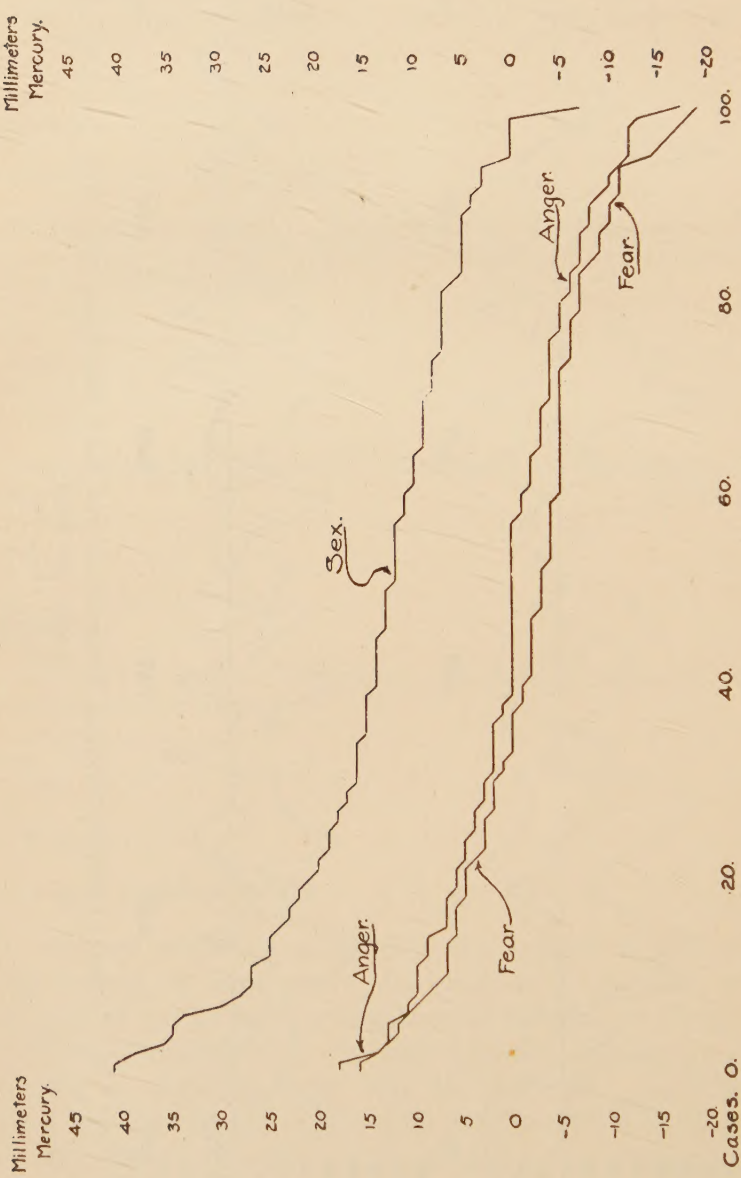

FIG. 2. GRAPHIC REPRESENTATION IN DISTRIBUTION IN MILLIMETERS MERCURY

Weak serve as a five point scale for reporting the degree of emotion. The question "Do you consider yourself 'emotional'?" is admittedly and consciously ambiguous. It was inserted as a rough check of the individual's judgment as to his "emotional make up," this term being interpreted according to current usage. The question "Was your attention distracted by the pressure on your arm?" is self-explanatory. Previous experience in making blood-pressure determinations has suggested that the mechanical stimulus of pressure has produced, in some cases, psychic disturbances.

RESULTS

In figure 1 the individual cases are arranged on the abcissa arbitrarily in the order in which they were tested. The ordinate is scaled in millimeters of mercury, the unit of blood-pressure measurement. The graph shows a consistent rise in blood-pressure with the sex stimulus, only one case in the 100 reacting by a drop in pressure. The curves for anger and fear show no characteristic reaction. A comparison of the three curves, per individual, shows no consistent inter-relationship, i.e., an individual with a very high rise for sex does not give a corresponding rise for anger, or, a drop with the fear stimulus does not give a proportional rise or fall with anger.

In figure 2 the distribution of results is shown graphically. This distribution may be tabulated as follows:

	SEX	ANGER	FEAR
	mm. Mer.	*mm. Mer.*	*mm. Mer.*
Maximum	41	18	16
Minimum	−7	−17	−19
Median	13	0	−3
Mode	12	0	−5
Mean	14.3	−0.1	−1.9
Mean Var.	7.2	5.2	−5.6

The relative subjective effect of the stimuli may be estimated by the distribution of the cases according to introspective report.

SEX		ANGER		FEAR		"EMOTIONAL"		PRESSURE DISTRACTION	
Report	Per cent	Report	Per cent	Report	Per cent	Report	Per cent	Report	Per cent
V.S	3	V.S.	4	V.S.	10	V.S.	8	V.S.	4
S	27	S	16	S	28	S	38	S	14
M	58	M	28	M	33	M	45	M	29
W	8	W	25	W	20	W	5	W	23
V.W.	4	V.W.	27	V.W.	9	V.W.	4	V.W.	30

Table 1 shows the relationship of the blood-pressure fluctuation to the introspective report. A study of the distribution indicates a lack of correlation between degree of blood-pressure change and degree of emotion as reported introspectively. The relationship

TABLE 1

Systolic blood-pressure changes

A. Sex stimulus

REPORT	NUMBER OF CASES	MILLIMETERS MERCURY										
		− 10, − 5	− 5, 0	0, 5	5, 10	10, 15	15, 20	20, 25	25, 30	30, 35	35, 40	40, 45
V.S.	3			2							35	
											39	
S.	27			0	9	12, 12	18, 16	22	27			
				0	5	13, 13	15, 19	24	25	34	36	41
				0		13, 14	19		27			
						14, 14, 14						
M.	58			0, 0	7, 7, 7, 7, 7	14, 11, 11	17, 17, 15	20, 20	28, 25			
		−7		4, 4	7, 5, 5, 5, 5,	11, 12, 12, 12	15, 16, 16	22, 23	25, 27	30	35	
				2	9, 9, 9, 9, 9	10, 10, 10, 10	16, 15, 13	23				
					8, 8, 6	12, 12	19					
W.	8				5, 5		15					
					7, 8	14	18	21				
V.W.	4			2	8	13	16					

Coefficient of Correlation, −0.258

TABLE 1—*Concluded*

B. Anger stimulus

REPORT	NUMBER OF CASES	MILLIMETERS MERCURY						
		−17, −10	−10, −5	−5, 0	0, 5	5, 10	10, 15	15, 20
V.S.	4	−15		−3		5	14	
S.	16			−1, −1	2, 0	9	11	
			−7	−4, −2	0, 0	7	12	
				−3	0, 3			
M.	28	−12	−7, −7	−2, −4	0, 0, 0	7	10	
		−17	−10, −6	−4, −4	0, 0, 2	9	10	
			−9	−5, −5	2, 1, 4		10	
				−5				
W.	25	−12	−6, −6	−4, −4	1, 0	5, 5		
		−11	−8, −8	−4, −2	0, 0	6, 6	10	
				−2, −3	0, 0			
				−5	2			
V.W.	27	−12	−10	−3	3, 3, 2	9, 7	12	
		−12	−8	−3	2, 4, 4	7, 6	11	18
			−7	−1	0, 0, 0		13	
					0, 0			

Coefficient of Correlation, 0.016

C. Fear stimulus

REPORT	NUMBER OF CASES	MILLIMETERS MERCURY						
		−20, −15	−15, −10	−10, −5	−5, 0	0, 5	5, 10	10, 15	15, 20
V.S.	10				−4, −1	4	7		
				−10	−1, −5	1	7		
							9		
S.	28	−16	−11	−7, −7	−5, −5, −5	0, 0	5		
		−17	−11	−7, −9	−2, −2, −4	0, 3	6	13	
			−15		−4, −3, −3	1	6		
					−1				
M.	33			−10, −9	−5, −5, −5	2, 2	7, 5	14	
		−18	−14	−6, −6	−4, −4, −2	3, 3	5, 6	10	
				−7	−2, −2, −2, −3	1	6, 8		
					−5, −5, −5				
W.	20		−11	−9, −7	−2, −5	2	5		
		−19	−11	−8, −6	−5, −5	3	7		16
					−5, −4				
					−3, −3				
V.W.	9			−10		0		13	
				−6	−4	2		13	
				−6				11	

Coefficient of Correlation, 0.034

was determined mathematically by Pearson's method of correlation using the formula:

$$k = \frac{\Sigma f d \times dy - n (K - x K - y)}{n (\sigma \times \sigma - y)}$$

The coefficients of correlation between blood-pressure readings and degree of subjective report are:

Sex	−0.26
Anger	0.02
Fear	0.03

The coefficients in these cases are so small that we must conclude that there is no correlation between degree of emotion as reported introspectively and degree of systolic blood-pressure change.

The blood-pressure fluctuations for anger and fear parallel each other rather closely while the fluctuations with the sex stimulus are markedly different from the other two. The relationship may be summarized as follows:

Anger

Maximum 18 mm.
98 Cases of 13 mm. or less.
98 Cases of 12 mm. or less.

Fear

Maximum 16 mm.
98 Cases of 13 mm. or less.
95 Cases of 11 mm. or less.

Sex

Maximum 41 mm.
25 Cases > 100 Anger cases.
46 Cases > 98 Anger cases.
49 Cases > 97 Anger cases.
29 Cases > 100 Fear cases.
46 Cases > 98 Fear cases.
57 Cases > 95 Fear cases.

DISCUSSION

These results seem to show that the degree of systolic blood-pressure change is not correlated with the degree of emotion as reported introspectively. This may be due to either the unreliability of the subjective report or the fact that blood-pressure changes are an independent variable. In support of the first supposition several investigators, Syz (18) in particular, may be cited.

There is sufficient evidence on hand, however, to conclude that blood-pressure changes occur with emotion so that we can not assume vascular reactions to be an independent variable. There is also reason to believe that similar changes, often to a lesser degree, may occur without any emotional content. It is a well known fact that blood-pressure is subject to daily rhythm due to ingestion, exercise, fatigue, etc., although the range, increase, decrease and time factors are not well agreed upon by the various investigators. In addition to these gradual or slow fluctuations there are sudden changes of blood-pressure which can not be accounted for by the factors of exercise, ingestion of food and the like. Landis reports (10) that fluctuations occur without the subject being aware of any emotion. As a partial check of this point in the present investigation, four subjects were asked to look at a picture which was designed to give no emotional stimulation. The subjects reported no consciousness of any emotion. The film required approximately the same length of time as the original one used in arousing emotions. The subjects' blood-pressure was taken at five minute intervals under exactly the same conditions as existed in the main investigation. There was considerable fluctuation of both systolic and diastolic blood-pressure. The range for the systolic pressure was 15 mm., considerably less of course, than in the case of the original picture. The result confirms the report of Landis that there are sudden transitory "unemotional" or physiological blood-pressure changes. We must consider, therefore, the emotional changes as superimposed on the physiological fluctuations. If the emotional stimulus be strong enough so that there is a considerable differ-

ence between the emotional change and the physiological change then the blood-pressure reading has a more significant value as far as its relation to emotion is concerned. Such is the case in figure 1 where the fluctuations with the sex stimulus are of sufficient height to make the physiological component negligible. The curves for anger and fear, on the other hand, are of little value for the emotional rises are not much greater than the physiological fluctuations.

If we let the rise in blood-pressure be represented by R, and let P represent psychological or emotional fluctuations, and p, the physiological fluctuations, then

$$R = P + p$$
As $P <$ or $p >$
P approaches R

Even though the reliability of subjective report be assumed this lack of correlation can be explained. Evaluating the strength of the stimulus by the distribution of the cases on the five point scale, we find the sex stimulus the strongest of the three, only 12 per cent reporting "weak" or "very weak" and in terms of blood-pressure only 16 per cent with a 5 mm. or less fluctuation. There is then, a rough group correlation. Also, considering the fact that the blood-pressure changes with sex are so great comparatively, the independent variable—physiological fluctuations—would become a more negligible factor and allow for a correlation between degree of emotion subjectively and degree of blood-pressure change. The fact that this does not occur may be attributed to the social factor of inhibition or repression of frank discussion of sex topics, and the shame or embarrassment in admitting sex emotions. This is substantiated by the fact that 58 per cent report "moderate," a large majority of which in terms of blood-pressure would have been expected to report "strong" or "very strong."

Distribution of report for the anger situation shows it to be the weakest stimulus of the three, 52 per cent reporting "weak" or "very weak." In this situation the physiological variations outweigh the psychological and the correlation is consequently

low. No doubt a stimulus provoking extreme anger would give more decided vascular changes, which would, however, be implicated with other physiological systems.

The fear stimulus ranks between the sex and anger as to strength. Twenty-nine per cent report "weak" or "very weak." Correlation is again low. Reactions to the stimulus are definite but varied. Their individual characteristics suggest the factors of environmental conditioning and temporary or permanent conditions of general nervous irritability. It should be noted that the fear stimulus is the only one of the three which is decidedly sensory, anger and sex being of the ideational type. Darrow (6) pointed out that ideational stimuli cause blood-pressure changes as indicated by heart variations, while sensory cause peripheral changes, e.g., vaso-constriction. If such be the case the diastolic blood-pressure should have been pronounced in the case of the fear stimulus. This did not prove to be the case.[1]

As has been indicated on figure 1 a rise of systolic blood-pressure with sex stimuli is the only consistent reaction of the three. This is in entire disagreement with Marston, although Landis found 15 cases out of 22 reacted to sex stimuli by an increase in blood-pressure. For a sex stimulus Marston simply introduced a person of the opposite sex to the subject. Landis used a series of pornographic pictures. Apparently differences in the type of stimuli used by various investigators, account for the divergence in results.

Anger may produce a rise or a fall. In 19 per cent of the cases there is no change at all. In 59 per cent of the cases the change if any, is not more than 5 mm., an amount most logically explained on the basis of physiological processes instead of emotion. The extreme changes show a nearly equal tendency to go up or down. A median and mode of 0 and a mean of -0.1 indicate the group trend. There obviously was no characteristic reaction for this emotion.

[1] The diastolic blood-pressure has been measured with each systolic reading in this experiment. Its relation to emotion has been reserved for a separate discussion.

The reactions to the fear stimulus, while just as variable as those with anger, show more definite trends and appear to be more directly the results of the emotion in question. Only 5 per cent gave no reaction. A modal point of -5 and a median of -3 indicate a tendency for blood-pressure to drop with the "choc" of surprise, even though there is a rise with 32 per cent of the cases. Seven cases showed a sudden transitory drop followed by a rise. In 4 cases the order was reversed, the immediate rise being followed by a fall. (In making the statistical interpretations the secondary fluctuation was ignored.) These results demonstrate a vascular reaction to the fear stimulus. The type of the reaction appears to be an individual matter, possibly the result of conditioning of the cardio-vascular nervous arcs or perhaps a result of the temporary condition of the individual's nervous system. In general the results suggest a vascular reaction to mental shock comparable to that of surgical shock.

There were 46 cases who reported "strong" or "very strong" as to whether they were "emotional" or not. There was no relation between this report and the amount of systolic blood-pressure change with the three stimuli. This may be the result of the ambiguity of the term "emotional" or, the unreliability of the subjective report. It is significant to note that 46 per cent report "very strong" or "strong" and only 9 per cent "weak" or "very weak."

Four subjects reported the effect of the pressure on the arm as "very strong." Of these four, one subject had a blood-pressure rise of 39 mm. with the sex stimulus, the other three, 11 mm. or less and were therefore below the average for the group. The reactions of this group with the stimuli of anger and fear were also not correlated with the report of "very strong." Apparently the emotional reaction to pressure on the arm was a constant factor, so that the difference between the normal pressure and the pressure with the emotional stimuli was not effected by it.

The lack of correlations and the inconsistencies of the above results suggest the hypothesis that systolic blood-pressure fluctuations are but a fractional part of a syndrome of bodily reactions occurring with emotional states. This is in consonance with

what is known about the physiological facts of blood-pressure. Vascular reactions can not, therefore, be used as an independent criterion of emotion. Rather, it is necessary to determine the relation of blood-pressure reactions to the general physiology of the body in order to obtain the proper perspective and true significance of emotional vascular reactions.

CONCLUSIONS

1. There is no correlation between degree of emotion as reported introspectively and degree of systolic blood-pressure change.
2. The type and degree of blood-pressure fluctuation with the emotions of sex, anger and fear in an individual, have no relation to each other.
3. Sex emotion is characterized by a rise in systolic blood-pressure.
4. Anger and fear have no characteristic vascular reaction.
5. Psychological fluctuations of systolic blood-pressure can not be measured independently of physiological fluctuations.

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